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Original Research Article

Outcome of Vascular Access in Pediatric Haemodialysis of Baghdad Hospitals

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Abstract

Vascular access is the ability to enter the vascular system. Three types of vascular access are used: arteriovenous fistula (AVF), arteriovenous grafts (AVG) and central venous catheters (CVC) as permanent or temporary.
The Aims of this study are to study the number of each type of vascular accesses,correlationwith some demographic data,complications, survival time and correlation with dialysis adequacy.
This is retrospective study based on 55 pediatric patients with CRF receiving maintenance HD in four pediatric HD centers in Baghdad from 1st March 2013 till end of March 2014.
As for Central venous catheters (CVC), we investigated: number of catheters inserted, insertion site; survival time and; and complications.As for arteriovenous fistula (AVF), we investigated: the number of failed and patent AVF, survival time and the complications.Adequacy of dialysis (Kt/V and URR) was calculated.
There was 172 HD vascular accesses in 55 patients; 38 (69.1%) were males and 17 (30.9%) were females. Mean age was 11.9 years.
TDL was the commonest VA among patients below 20 Kg (40%), while PDL was commonest among patients with 20 – 30 Kg and above 30 Kg body weight (41.2%) and (47.8%) respectively. For 120 patients (69.8%) temporary dual lumen (TDL) were inserted, and for 27 patients (15.7%) AVF, and for 25 (14.5%) permanent tunneled dual lumen (PDL).
Majority of TDL were inserted in right internal jugular veins in 42.98%, and left internal jugular veins in 35.54%.
Infection and thrombosis are commonest complications observed in both dual lumen (41.9%, 27.9%),) and AVF (33.3%, 30.1%). Six out of 27 AVF failed to mature (22.2%),
Survival time of AVF was 456.3±80.1 days which is more than that of PDL (187.2±36.3 days) and TDL (132.3±1.13 days).Adequate dialysis was seen in 50% of patients dialyzed by AVF, in 26.7% with PDL and in 23.3% with TDL.CVC are the main type of VA used. Infection and thrombosis are the most common complication. AVF provide longer survival time than CVC.

Key words: Hemodialysis, children, vascular access .

دراسة المنفذ الوعائي(الدموي) لمرضى الغسل الكلوي الدموي للاطفال في مستشفيات بغداد

الخلاصة

يستعمل المنفذ الوعائي الدموي لدخول المجرى الدموي . هناك ثلاث انواع من المنفذ الوعائي الدموي: الربط الوريدي الشرياني, ترقيع الشرايين والأوردة و المنفذ الوعائي الدموي المؤقت والدائمي .

تهدف هذه الدراسة الى دراسة عدد كل نوع من المنفذ الوعائي الدموي المستعمل والعلاقة مع بعض الخصائص للمريض. دراسة المضاعفات , معدل الايام لكفاءة المنفذ الوعائي الدموي والعلاقة مع فعالية الغسيل الدموي .

الدراسة استعادية اشتملت على 55 طفل مصاب بالعجز الكلوي المزمن وعلى الغسيل الدموي المبرمج من 4 مراكز الغسيل الدموي للاطفال في بغداد للفترة من الاول من اذار 2013 لنهاية اذار 2014. بالنسبة للمنفذ الوعائي الدموي , تمت دراسة العدد, مكان الادخال, , معدل الايام و المضاعفات بالنسبة للربط الوريدي الشرياني , تمت دراسة : العدد, الفاشلة والفعالة , معدل الايام و المضاعفات.

تم احتساب فعالية الغسيل الدموي حسب المعادلات. عدد المنفذ الوعائي الدموي الكلي 172 لكل المرضى . عدد الذكور 38 (69,1%) الاناث 17 (30,9%) . معدل العمر 11,9 سنة . المنفذ الوعائي الدموي المؤقت هو الاكثر استعمالا للمرضى دون 20 كغم (40%) , بينما المنفذ الوعائي الدموي الدائمي للمرضى 20 – 30 كغم (41,2%) والمرضى اكثر من 30 كغم (47,8%) على التوالي.

تم ادخال المنفذ الوعائي الدموي المؤقت الى 120 مريض (69,8%) و الربط الوريدي الشرياني الى 27 مريض(15,7%) و المنفذ الوعائي الدموي الدائمي الى 25 مريض(14,5%) . معظم المنفذ الوعائي الدموي المؤقت تم ادخالها عن طريق حبل الوريد الداخلي الايمن بنسبة 42,98% .

الالتهابات والخثرة الدموية كانت اكثر المضاعفات حدوثا مع المنفذ الوعائي الدموي بنوعيه بنسبة (41,9%) و (27,9%) . ومع الربط الوريدي الشرياني بنسبة (33,3%) و (30,1%) . لوحظ فشل الربط الوريدي الشرياني لستة حالات من المجموع الكلي 27 (22,2%) . معدل الايام لكفاءة الربط الوريدي الشرياني كان 80,1± 456.3 يوما وهو اكثر من معدل الايام لكفاءة المنفذ الوعائي الدموي3 ,36,± 187,2 يوما واكثر من معدل الايام لكفاءة المنفذ الوعائي الدموي الدائمي 1,13± 132,3 يوما.

لوحظت مع فعالية الغسيل الدموي لدى 50% من حالات الربط الوريدي الشرياني, 26.7% من حالات المنفذ الوعائي الدموي الدائمي و 23,3% من حالات المنفذ الوعائي الدموي المؤقت .

استنتاجات هذه الدراسة تشير الى ان المنفذ الوعائي الدموي هو الاكثر استعمالا . الالتهابات والخثرة الدموية اكثر انواع المضاعفات حدوثا . معدل الايام الربط الوريدي الشرياني اعلى من المنفذ الوعائي الدموي.

الكلمات المفتاحية : الغسيل الكلوي الدموي, الاطفال, المنفذ الوعائي الدموي.

Introduction

A progressive rise in the number of patients accepted for renal replacement therapy (RRT) has been reported worldwide [1].

A well functional access is also vital in order to deliver adequate hemodialysis therapy[2].

Vascular access is the ability to enterthevascularsystem. Three types of vascular access are used: arteriovenous fistula (AVF), arteriovenous grafts (AVG) and central venous catheters (CVC).

The ideal vascular access delivers a flow rate adequate for the dialysis prescription, has a long use - life, and has a low rate of complications [3].

The first AVF was described by Brescia et al. in 1966 and subsequently has become the ideal vascular access in both adults and children. This is mostly due to its low complication rates and long life span [4].

Complications of AVF can be early which include inflow problems due to small or atherosclerotic arteries, or stenosis, late causes for failure of AVFs include venous stenosis, thrombosis, and acquired arterial lesions such as aneurysms or stenoses [5, 6].

AVG were the most commonly used type of dialysis access in the U.S. However;they do not last as long as AVF and they have higher rates of infection and thrombosis [7]

Central venous catheters are the most commonly used vascular access in children in North America [4].

There are advantages to a CVC, including the ability for it to be used it immediately and the absence of needle cannulation. However, the disadvantages of using a CVC include its short life span, thrombosis, infection, malfunction and possible fibrin sheath formation [4]. Median survival times of CVCs have been reported to range from 4months to 10.6 months [4].

Aims of The Study

Study the prevalence of each type of vascular accesses. Correlation of vascular accesses with some demographic data including age, gender, and body weight Study complications, survival time and correlation of vascular accesses with dialysis adequacy.

Materials and Methods

This is a retrospective cohort study conducted on 55 patients on HD.

All patients starting HD under the age of 18 years, registered with the HD centers during the period from January 2011 through November 2014, and who remained on HD for 6 months or more, were included.

Four pediatric HD centers in Baghdad participated in the study which is 1. Hamida Al musafat HD center /ImameinKadhimein MedicalCity. 2. Iskan HD center/ Child Central Teaching Hospital. 3. Ibn Al - Baladi HD center 4.Al-Karama HD center. Approval from each Institutional Review Board of these centers was obtained.

Data were collected from medical records of the patients, including: gender, age, dry weight of patient, age of onset of CRF, age at initiation of HD, duration of HD.

HD data including: number of sessions per week, hours per session, type of vascular access at time of study (current vascular access), and dialysis adequacy parameters of each patient.

As for CVC, we investigated: number of catheters inserted,insertionsite; indwelling time and; and complications. All CVC-related or AVF-related infectious events were registered.

As for AVF, we investigated: the number of previousfailed access construction attempts; the number of previous patent AVF; failure cause; the time elapsing from construction to first puncture , survival time and the complications with AVF.

Pre and Post dialysis urea was collected in order to calculate adequacy of dialysis: Kt/V and Urea reduction rate (URR) [8, 9, and 10]

Single pool Kt/V = −Log n (R − 0.008t) + (4 − 3.5R) UF/BW

Where R is the ratio of pre dialysis urea to post dialysis urea, *t* is the time of dialysis in hours, and *BW* is body weight in kg.,

The ratio Kt/V >1.2 is regarded as adequate

URR % = 1 – (Post dialysis urea / Pre dialysis urea) × 100

URR > 65 – 70% is regarded as adequate

After analysis of the medical records, the patients were examined with the aim of collecting information that was not present in the records or not mentioned by caregiver, chiefly regarding previously failed AVF construction attempts or previously used CVC lines

Data categorization was based on the following definitions:

Infection-Because of the impossibility to identify the infection-confirming results of the blood cultures in the records, a CVC infection was considered to exist when CVC removal was due to fever, without any other infectious source, and/or when antibiotics were started, as diagnosis of exclusion[11].

Thrombosis: was considered to have been the outcome of AVF and CVC when no blood flow was achieved, in spite of attempts to relieve obstruction. There are several different types of thrombotic events, which include Intraluminal Obstruction from clotted blood and or accumulation of fibrin around the distal end of the catheter [11].

Primary failure: A failure of patency within the first 30 days after the placement of the AVF before successful cannulation [12].

Mechanical dysfunction: Non Thrombotic which are mainly external causes of catheter obstruction include kinked tubing, Closed clamps, Constriction of the CVC due to improperly placed insertion site suture malposition of the catheter, Catheter tip migration, Patient position causing catheter tip to become occluded in the vessel [12,13].

Accidental extraction: for CVC lines which be dislodged by patients or thecare giver at home (especially during take of clothes) or by staff in hospital (forcefully aspiration or flushing the catheter) [13].

Stenosis: of AVF which could occur in improperly created fistula, stenosis is unable to accommodate increased flow rates, the result will be swelling of the arm and cyanosis as well as formation of collaterals on the chest wall [14].

Aneurysm:Is a localized, blood-filled balloon-like Bulgein the wall of a blood vesselof an AVF.Aneurysms of the AV fistula are usually the result of destruction of the vessel wall and replacement by biophysically inferior collagenous tissue [14].

Survival time: Total function of the AVF or CVC from construction of AVF or insertion of CV till access failure, loss of follow-up or renal transplantation [12].

Steal syndrome:is rare ischemic complication leads to reduced blood flow distaly with formation of collaterals [14, 15].

The collected data were processed and analyzed with the Excel (2000) and SPSS (11.5 for Windows) programs. We described the data with frequency tables, medians and means. Categorical data were shown in proportions and expressed as percentages. The chi-squared test, with Yates correction, was used for proportion comparison.

Results

This study investigated 172 HD vascular accesses in 55 patients; 38(69.1) were males and 17 (30.9) were females.

Age of patients ranged from 2.6 -19.3 years, mean age was 11.9 years and median age was12.1 yrs.Most common age group was>12y involved 27 patients (49.1%).

Among the study group; for 120 patients (69.8%) temporary dual lumen (TDL) were inserted, and for 27 patients (15.7%) AVF, and for 25 (14.5%) permanent tunneled dual lumen (PDL). while no case involved Graft shunt insertion was observed (Figure-1.

The initial access in 50 patients (90.9%) for their first HD was TDL,while in 4 patients (7.3%) was PDL, and only one patient (1.8%) AVF was his initial access for HD which was done while he was outside Iraq as he was diagnosed as case CKD and advised to make AVF for future HD (Table 1).

Regarding the current HD VA (at time of study); in 21 patients (38.2%) was AVF, 17 patients (30.9%) TDL, and in 17 patients (30.9 %) now dialyzed by PDL (Table 1).

Majority of TDL were inserted in right internal jugular veins in 42.98%, and left internal jugular veins in 35.54% (Figure-2).

Table 2 shows relation of VA with demographic characters of patients. Most males in this study dialyzed by AVF as their current VA for HD in 17 out of 36 (47.2%), while still the larger percent of females continue HD by TDL in 8 out of 19 females (42.1%).

Most children below 6 years of age had TDL as current VA for HD (75%), while patients in the age group of 6 - 12 years had PDL (41.7%), AVF was mostly observed in patients above 12 years of age as VA for HD (48.2%).

Regarding current VA for HD in relation to body weight, TDL was the commonest VA among patients below 20 Kg (40%), while PDL was commonest among patients with 20 – 30 Kg and above 30 Kg body weight (41.2%) and (47.8%) respectively . There is no statistical difference observed.

Infection was the most common complication reported with CVC in (41.9%)cases, followed by thrombosis in (27.9%), mechanical dysfunction in (18.6%), accidental or incidental extraction in (6.9%) and hem pneumothorax in (4.7%). [Figure 3]

Recorded complicationswithAVF included infection occur in most cases (33.3%) followed by thrombosis in 30.1% , failure of maturation in 25 % while aneurysm observed in 8.3% and no case of steal syndrome was observed in this study. (Figure 4).

Average time of HD,as calculated by months + days;in AVF patients was more than PDL patients and TDL patients with figures of 14.2 months, 4.9 months and 3.9months respectively (Table 3).

This is supported when we calculated mean days ofSurvival time;as calculated by mean of days of each type of vascular access. As shown in Table 4; Survival time ofAVF was 456.3±80.1 days which is more than Survival time of PDL (187.2±36.3 days) and Survival time of TDL (132.3±1.13 days).The difference was highly statistically significant (Table 4).

Adequate dialysis:Kt/V> 1.2 and URR >60, was found in 15 patients (50%) dialyzed by AVF, in 8 patients dialyzed with PDL (26.7) and in 7 patients dialyzed with PDL (23.3%). The difference was highly significant as shown in Table 5.

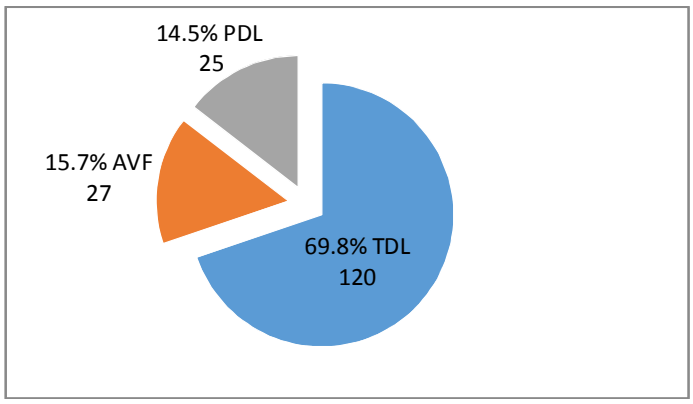

Figure 1: Number and percentage of each vascular access (TDL, PDL, and AVF)
TDL:temporary dual lumen; PDL: permanent tunneled dual lumen AVF: Arteriovenous fistula

Table 1: comparison between initial and current vascular access in 55 patients

Type of VA	Initial(VA)		Current (VA)	
	No.	100 %	No.	100 %
TDL	50	90.9	17	30.9
PDL	4	7.3	17	30.9
AVF	1	1.8	21	38.2

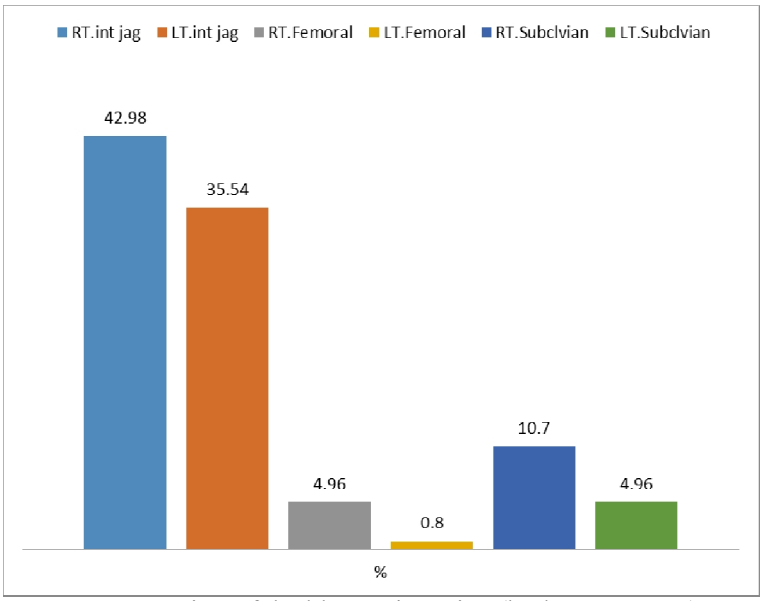

Figure 2: sites of dual lumen insertion (both TDL , PDL)

Table 2: Current Vascular accesses relation with gender , age , weight of patients

Vascular accesses	Male		Female	
	No.	%	No.	%
TDL	9	25	8	42.1
PDL	10	27.8	7	36.8
AVF	17	47.2	4	21.1
TOTAL	36	100%	19	100%

Vascular accesses	0-6 years		6-12 years		>12 years	
	No.	%	No.	%	No.	%
TDL	3	75	9	37.5	5	18.5
PDL	1	25	10	41.7	9	33.3
AVF	0	0	5	20.8	13	48.2
TOTAL	4	100%	24	100%	27	100%

*Vascular accesses	10-20 Kg		20-30 Kg		>30 Kg	
	No.	%	No.	%	No.	%
TDL	6	40	5	29.4	7	30.5
PDL	4	26.7	7	41.2	11	47.8
AVF	5	33.3	5	29.4	5	21.7
TOTAL	15	100%	17	100%	23	100%

*P = 0.00623 (not significant using person Chi- square test at 0.05 level of significance)

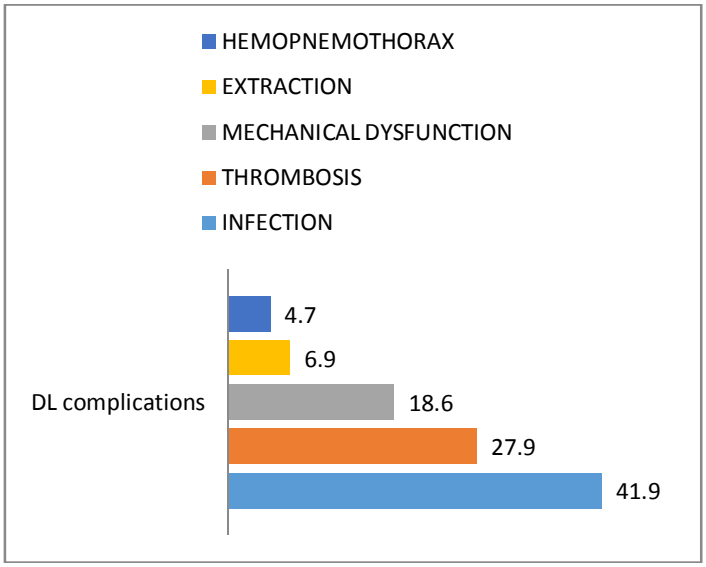

Figure 3: Central Venous Catheters complications

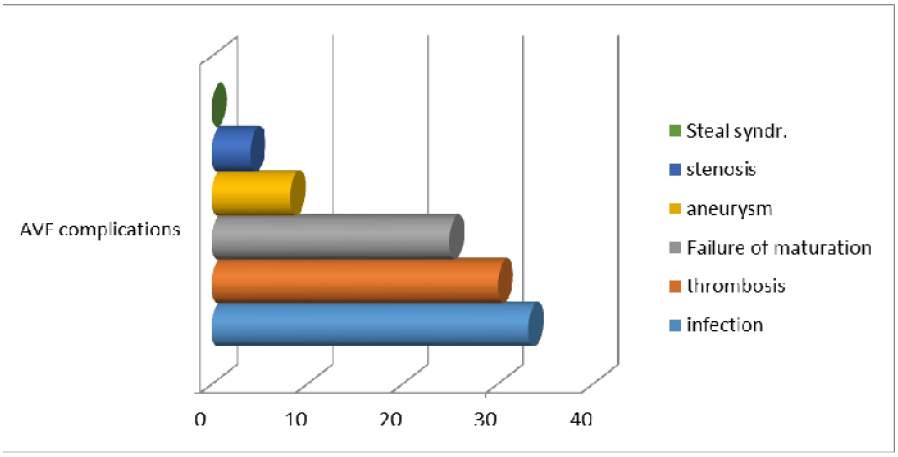

Figure 4:AV fistulae complications

Table 3: Average time of haemodialysis in different vascular access

Vascular accesses	No	Average time (months. days)
TDL	120	3.9
PDL	**25**	4.9
AVF	**27**	14.2

Table 4 : Survival time of each type ofvascular access

TYPE OF VA	Mean Survival time in days	P-Value
TDL	132.3±1.13	0.002
PDL	187.2±36.3	0.0005
AVF	456.3±80.1	0.0002

P = 0.0027 (significant using person Chi- square test at 0.05 level of significance)

Table 5: Dialysis adequacy in comparison with each type of current vascular access

VASCULARE ACCESES	ADEQUATE DIALYSIS (No. of patients)		INADEQUATE (No. of patients)		P-Value
	No.	%	No.	%	
TDL	7	23.3	10	40	0.003
PDL	8	26.7	9	36	0.0002
AVF	15	50	6	24	0.0001
TOTAL	30	100	25	100	0.0033

Adequate dialysis : Kt/V> 1.2 and URR > 60

P = 0.0033 (significant using person Chi- squaretest at 0.05 level of significance)

Discussion

In our country there's obvious increasing rate of pediatric hemodialysis with developmentof pediatric HD centers since 2010.

Mean age of patients at start of HD in 2 studies were 12.5 years and 13.3 ± 3.4 years respectively[12, 16] which is more than mean age of patients in this study. This may be related to earlier presentation of our patients with CRF with most cases related to congenital or metabolic causes of CRF rather than glomerular diseases. This was highlighted by Brazilian study which detected GN in 46% of cases[16].

According to the North American Pediatric Renal Transplantation Cooperative Study (NAPRTCS)[6], 77.7% of the children in

the USA start HD with a CVC, against 12.3% with an AVF and 7.3% with prosthesis. In other study; 51% of patients started HD with a CVC [16].

In this study, only one patient started HD with a AVF, this might be related to less number of vascular surgeons trained to construct an AVF in children especially low weight below 20 Kg.

The National Kidney Foundation's Disease Outcome Quality Initiative (NKF-DOQI) guide-lines, produced in 1997, emphasized the superiority of arteriovenous fistulae (AVF) as vascular access in patients on chronic hemodialysis. Challenges in pediatric hemodialysis patients include poor superficial venous vasculature[17].

Most studies of vascular access in low weight children [18,19] have reported a higher rate of CVC use than of AVF use, mainly due to surgical difficulties. This is especially relevant because of the correlation between CVC use and mortality [19].

AVF patency success is directly related to the patient's clinical status, age, weight, sex and primary disease, and also to the surgical technique employed and the experience of the multi-professional team. Setting a permanent vascular access in the pediatric population is technically more challenging. Although microsurgery can improve the technical results, the surgeon's experience seems to be the most significant factor for success of the procedure [4].

Nearly similar to our results, Rina et al reported that 89.6% of CVC were inserted in Jugular vein.[12]. The subclavian vein being best avoided due to the risk of stenosis [3]. CVC insertion in the right internal jugular vein affords straighter access to the right atrium, compared to the left vessels, and also carries a lower risk of infection, compared with the other sites [20].

CVC related infection is the main barrier to the use of long dwelling catheters, being the main reason for catheter removal and the main cause of morbidity and mortality among dialysis patients [3, 21].

Data from the United States Renal Data System (USRDS) indicate that the rate of sepsis remains on the increase among dialysis patients, with increase in the rate of hospital admissions for treatment of vascular access infection [22, 36].

Lower rates of infection of 35% and 17% were reported in two studies [16, 23] .

Sherma et al reported thrombosis in 33% of patients. [23]. In addition accidental extraction was detected in 5.4% and 8.9% in two studies [23,24]. These results are in agreement with this study.

Primary AVF failure is described in the literature and found at varied rates, both in adults and children. This rate has ranged from 10% to 37.8% [12, 16, 25].

Variable figures reflect differences of the surgeon's expertise, surgical technique and vessel integrity, vein caliber, patient's size or age.

Thrombosis is one of the main causes of AVF complications [4]. AVF failure due to thrombosis occurred in one third of patients with low survival times, and this carry us for multiple temporary catheters had to be inserted in different sites, this will lead to stenosis of central vessels, which precluded the use of any type of vascular access, including prostheses, and even renal transplantation.

Thisdramatic situation is a reflex of many factors: the long period the children remain on HD, the impossibility of performing peritoneal dialysis because of repeat peritonitis, an inadequate choice of the dialysis modality, the incapacity of the family to face the treatment challenges, and the delay to receive a kidney graft [16].

Sharma et al reported CVC survival at one year of 62%[23]. Briones et al reported one year primary patency of AVF of 50%[26].

Rina et al study found AVF survival time of 42.5 ± 51.9 months which is more than CVC survival time of 36 ± 2.7months [12]. These findings are supportive to our results.

This study showed significant correlation between dialysis adequacy and vascular access. This is similar to study done in India [27].

CONCLUSION:CVC are the main type of VA used among Iraqi children on HD. Infection and thrombosis are the most

common complication. AVF provide longer survival time than CVC.

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